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AN EXAMINATION OF SURVIVAL RATES BASED ON EXTERNAL FLOTATION DEVICES: A HELICOPTER DITCHING REVIEW

DRY-MIXING OF SUB-MICRON B AND $BaCrO_4$ PARTICLES FOR USE IN A TIME DELAY COMPOSITION

PREPARATION, CHARACTERIZATION AND OUTPUT TESTING OF SALTS

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President's Message

Christy Cornette--2007 SAFE President

My first SAFE Symposium was in 1985 in Las Vegas. I remember being energized by the experience and was immediately hooked on SAFE. There was so much to take in: the hall full of exhibits, interesting and stimulating technical presentations, the Sir James Martin lecture, General Spruance's "The Will to Live" lecture, the demos, and the interaction at the social events—it was awe-inspiring to a newcomer and captivated me. During the Symposium, I encountered committed and enthusiastic people who were making a difference in the survival and life support community.

There was a contagious feeling of camaraderie and passion among the members and I knew I wanted to be involved and play an active part in the organization. In fact, one of my current goals as President is that all newcomers have that same experience at our symposium: I want it to be the optimal experience.

One common question we hear is, "What do I get for my SAFE dues?" I feel that paying my SAFE dues is similar to supporting one's own favorite charity. You give to your favorite charity because you feel strongly about it and believe in its cause. Your giving fosters the organization's existence and helps to further its mission and goal. The reason I pay my dues is not only to receive the newsletter, journal, discounts at registration and so forth, as I feel those are bonuses of my membership. The value I get has nothing to do with tangible items—it's the intangible things from which I truly benefit.

I see SAFE as having a simple objective: make people in the world safer. You have heard the saying that "knowledge is power" but knowledge can also be the difference between life and death. Making a split-second decision in an emergency situation is always easier if you know what course of action to take. SAFE provides safety and survival knowledge and sharing those lessons learned is a vital part of part of our information network as an organization.

SAFE is about preventing injuries and saving lives. For instance, no one can say that they have listened to General Spruance's session and not learned valuable safety tips. When a session or an article makes you say "I never thought of it that way and that is good to know," then SAFE has done its job.

I am so proud of how our SAFE vendors help solve our warfighters' problems. They work tirelessly to be a part of the solution and support our troops in their tough and dangerous mission to protect us on the home front. Developing products that have to work in complex environments is not an easy job—we need our Forces to be safer and more protected than they have ever been before. It is nice to see that some things are more important than making a buck.

Our first SAFE Board of Directors meeting was in San Antonio where we co-located with the Air Force Industry Days conference. The meeting was very well attended and very productive. I want the Board of Directors to look at the symposium from the attendees' and corporate exhibitors' perspective and truly listen. Doing this, along with looking forward to the future, is key. I want to try to implement ideas that make good sense and provide value. Some changes may work or may not but we don't know unless we try. The board that follows mine will learn from these changes and continue with them or change them. Any change involves risk. I see my role as doing what benefits SAFE and protects it for the future.

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An Examination of Survival Rates Based on External Flotation Devices: A Helicopter Ditching Review from 1971 to 2005

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ABSTRACT

The data set consists of 511 helicopter ditching cases in which we could determine the number of occupants, the final position of the aircraft, the presence of external flotation devices and the number of surviving occupants. The final position of the helicopters indicated that 56 floated upright, 326 inverted with 156 of those sinking. It appears that helicopters that invert and sink significantly reduce the survivability rate of the occupants ($p < .001$). In addition, 298 of the helicopters were equipped with external flotation devices, while 109 did not have flotation devices. External flotation devices appear to assist in keeping the helicopters floating on the surface of the water ($p < .005$). However, it is not clear that survivability in helicopters with external flotation devices is higher than without the devices. This result may be partially due to the fact that approximately 46.5% of all helicopter ditching events involve the helicopter sinking. The results also indicate that 42% of helicopters fitted with external flotation devices still sank. It appears that installation of external flotation devices alone is not sufficient to result in a higher level of survivability following a helicopter ditching.

INTRODUCTION

Past research concerning helicopter ditchings and forced landings typically examines technical aspects of the accidents such as mechanical failure, while others explore the difficulties faced by the occupants during egress of an overturned aircraft (Brooks, 1998, 1988a, 1988b; Clifford, 1996; Contarino, Loeslein, & Kinker, 1999; Reader, 1990). The Federal Aviation Administration (FAA) defines a helicopter ditching to be "an emergency landing on the water, deliberately executed, with the intent of abandoning the rotorcraft as soon as practical. The rotorcraft is assumed to be intact prior to water entry with all controls and essential systems, except engines, functioning properly" (Chen, Muller, & Fogarty, 1993, p. 3). The Civil Aviation Authority (CAA) describes a ditching as a planned event in which a flight crew knowingly makes a controlled emergency landing in water (CAA, 1995).

Although the FAA and CAA identify a ditching as a situation in which the aircrew have planned and deliberately executed the landing, however, there are occasions when this is not the case. Therefore, this study has included all cases in which the helicopter has unintentionally landed on the surface of the water. A helicopter ditching situation can also be divided into three basic phases: impact, position of the aircraft following impact (post-impact), and egress. Each one of these phases has its own unique problems for an individual trying to survive the crash. However, this paper will focus only on the position of the helicopter in relation to the surface of the water. The post-impact phase typically involves the helicopter capsizing and filling with water and possibly sinking; however, the aircraft may also remain upright. Therefore, the position of the helicopter (post-impact) is of considerable interest as it relates to survivability of the occupants. The task complexities placed on someone trying to egress from an inverted helicopter that is at the surface of the water are undoubtedly less than those experienced if the aircraft is rapidly sinking to the bottom of a lake or ocean.

In most cases, if an inversion takes place, it is within a very short period of time. Clearly, if a person does not know what to do during this period of time (egress phase), surviving the ditching is considerably more difficult. Additionally, a helicopter that has inverted can either float or sink. This post-impact position of the aircraft is related to the structural components such as auxiliary flotation devices and any air that may be trapped inside. Chen et al. (1993) reported that if a helicopter sinks after it inverts, survival rates will be significantly reduced.

Current flotation devices for the helicopter can be armed by the aircrew prior to water impact or deployed by water activated mechanisms. In addition, the flotation bags are filled with carbon dioxide and nitrogen that must inflate all bags at the same time to avoid asymmetric buoyancy. Moreover, past research has also explored the possibility that external flotation devices mounted low on the fuselage of the helicopter are associated with higher survivability of the passengers and crew (Chen et al., 1993; Clifford, 1996; CAA, CAP 641, 1995; Reader, 1990).

By examining the most recent preliminary ditching reports (last five years), the recommendations made by both the CAA and FAA concerning flotation devices can be examined for effects on survival rates and survivability. For example, Reader (1990) suggested that the designs of external flotation devices are vulnerable to impacted forces, which may cause them to become separated and/or to deflate rapidly. Clifford (1996) reiterates Reader's suggestions and points out that of the 61 military ditchings examined 50 (81.8%) inverted, either immediately or delayed. The fact that helicopters have a high center of gravity due to the majority of the weight located in the main gearbox and rotor systems is generally cited as a contributing factor for inversion. Moreover, the compartments located at or below the water line contain mostly air or fuel. This combination of a high center of gravity and air and fuel trapped in the lower compartments in conjunction with the turning movement of the main rotors coupled with a flotation device that may or may not remain intact represents a difficult challenge for engineers to overcome when designing external flotation devices (Brooks, 1989; Chen et al., 1993; Clifford, 1996; CAA - CAP 641, 1998, CAA – CAP 719, 2002; Reader, 1990).

The majority of published reports on the difficulties faced by members of the rotor wing community during a ditching have been conducted by or for governmental agencies in an effort to better understand some of critical issues. In many of these government reports, a discussion concerning helicopter flotation devices and crew survivability has been examined (Chen, Muller, & Fogarty, 1993; Clifford, 1996; CAA, CAP 641, 1995; Reader, 1990). Although current legislation from both the CAA and FAA strongly recommend the use of external flotation, they fall short of mandating such devices be installed for over water operations that do not involve ferrying passengers.

Hypotheses. There are two fundamental hypotheses that were tested through the data analysis and are as follows:

1. The first and somewhat intuitive hypothesis is that survivability is affected by the final position of the helicopter in relation to the surface of the water.
2. The second hypothesis under investigation is that flotation devices will contribute to the overall survivability by keeping the helicopter at the surface of the water.

METHODS

Procedures. To examine the two hypotheses, a global database of helicopter ditching reports has been collected mainly from the National Transportation Safety Board's (NTSB) accident database, CAA, FAA, and the Transportation Safety Board of Canada reports (Baker & Bellenkes, 1996; Chen, Muller, & Fogarty, 1993; Clifford, 1996; CAA, CAP 641, 1995; Reader, 1990). The data set includes 511 ditching reports that span more than three decades from 1971 to 2005. Moreover, the data includes over 70 different helicopters from more than 10 countries. There were no exclusion criteria, such as type of helicopter operation placed on the reports. The inclusion criteria were that the ditching of the helicopter was an unintentional landing on the water, and that there was sufficient information about the position of the helicopter and the installation of external flotation devices for appropriate statistical analyses to be carried out.

Data Division. The complete data set is divided into 18 different categories; however only a few of these will be examined in this study. Chen et al. (1993) point out that survival rates are influenced by inversion rates, therefore this variable will be of major interest. Furthermore, they suggest that if the helicopter rolls over immediately there will be a higher rate of injuries and fatalities. This report examined the relationship between survival and inversion of the aircraft as well as several other variables. The first to be examined is the flotation device status of the helicopter. Many of the reports lacked the information necessary to discern whether the helicopter in question was equipped with flotation devices. Therefore, it was determined that a typical configuration of the aircraft would be used to decide status of flotation. For example, all Canadian and British military Sea Kings are equipped with external flotation devices; therefore, regardless of whether the report explicitly provided information about the use of flotation devices, it can be reasonably assumed that external flotation was installed. Moreover, this determination can also be considered reliable in so far as Joint Air Regulations and the FAA require helicopters to carry external flotation while transporting people over water more than 10 minutes away from land (FAA-7.1.8.18, 2002; JAR OPS 3.843(d), 1999). Based on this assumption, 298 (58%) of the helicopters in the data set were determined to be equipped with some form of external flotation. Although an assumption was made with regard to the installation of external flotation devices, no such assumption has been made concerning the functioning of the equipment or whether the pilots had the opportunity to deploy the devices during the ditching. Therefore, any analyses reporting use of flotation was based on reports that explicitly indicated whether the devices were used.

Survival rates are based specifically on the number of survivors divided by the total number of occupants. However, survivability for our purposes was categorized as either less than or equal to (≤) or greater than (>) 50% of the occupants surviving the ditching.

Data Analysis. As all data is of a nominal nature, Chi-square analyses were used to examine relationships between survivability and all other variables. Furthermore, three separate outcome conditions were used during analysis of this data: float upright, float inverted and inverted and sank. There were no reported cases in which the aircraft sank in an upright position. This is probably due to the top-heavy configuration of helicopters.

RESULTS

General Results. Of the 511 ditching reports, 382 cases indicated the final position of the helicopter. Of these 382, 56 (15%) of the helicopters stayed upright on the surface of the water while passengers and crew evacuated and 326 (85%) of the cases reported that the helicopter inverted. Of the 326 cases that inverted, 250 capsized immediately. Also within the 326 ditching reports that indicated inversion of the helicopter, the data show that 96 remained floating at the surface and 156 of the aircraft sank. Unfortunately, 76 investigation reports did not indicate whether the capsized helicopter sank or floated .

An examination of the overall data set (511 cases) indicated that the overall occupant survival rate was 66%. This is consistent with Clifford's (1996) study that identified an overall survival rate of 62.5 % for civilian helicopter operations.

The 511 cases represent a total of 2478 individuals being involved in the ditchings. Of the 2478 people, 1312 (53%) received some form of injury. Of the 1312 injured individuals, 835 (64%) received fatal injuries.

Figure 1 shows the yearly frequency of the 511 cases spread across the full period (1971 to 2005).

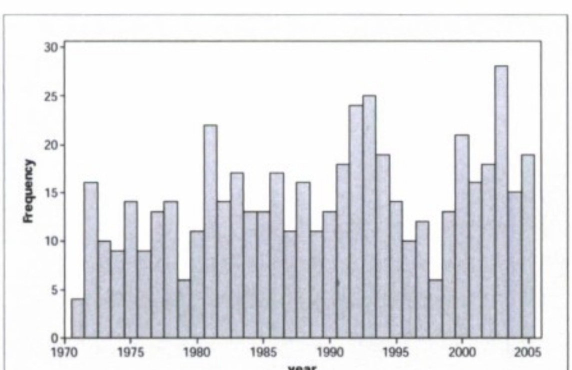

Figure 1. Total ditching cases from 1971 – 2005.

Of the 511 cases, only 416 (81%) cases contained sufficient information to confirm or reasonably assume whether the helicopter was equipped with flotation devices. Within the 416 cases, 108 (26%) did not have flotation installed. Although the remaining 298 helicopter had external flotation devices, in 82 (27.5%) cases the aircrew did not deploy the flotation devices and the aircraft sank below the surface.

Flotation Devices & Buoyancy. In order to examine the relationship between external flotation devices and the position of the helicopter in relation to the surface of the water, a Chi-square analysis was conducted (Table 1). Within the 298 ditching reports that indicated the presence of external flotation, a total of 241 cases indicated both the presence of external flotation and the final position of the helicopter. Based on the 241 cases, the results of this analysis indicate a positive effect of flotation devices and the helicopter remaining on the surface ($p = .005$). Results in Table 1 indicate that 113 (88%) of the helicopters that remained at the surface after ditching were fitted with flotation devices, whereas only 16 (12%) did so without flotation devices installed.

Table 1. Buoyancy versus the installation of flotation devices.

Position of the helicopter	No Flotation installed	Flotation installed	Total
Sank	30	82	112
Float	16	113	129
Total	46	195	241
($\chi^2 = 8.030$, $df = 1$, $p = .005$)			

Buoyancy & Survivability. Within the full dataset 326 cases indicated that the helicopter inverted. However, only 307 cases indicated the position of the helicopter and information about whether it sank or floated. The reports identified that 152 helicopters remained at the surface and that 155 sank . Of the 152 cases that floated, only 56 (37%) remained upright. A significant relationship ($\chi^2 = 55.856$, $df = 1$, $p < .001$) was found to exist between the position of the helicopter and survivability (≤/> 50%) (Table 2). This result supports the first hypothesis.

Table 2. Survivability versus position of the helicopter.

Survivability	Sank	Float	Total
≤50%	80	18	98
>50%	75	134	209
Total	155	152	307
($\chi^2 = 55.856$, $df = 1$, $p < .001$)			

Flotation devices & helicopter position. Table 3 demonstrates that a significant relationship exists between position of the helicopter and the presence of external flotation devices ($\chi^2 = 10.077$, $df = 1$, $p = .002$). Flotation devices were installed on 298 of the helicopters involved in this study. However, 54 of those ditchings did not indicate the position of the helicopter. Flotation devices were not installed on 108 of the helicopters; however, 43 of those cases did not indicate the position of the helicopter. Therefore, when the analysis was conducted to determine if external flotation devices affected the position of the helicopter only 309 cases could be used.

Table 3. Flotation devices installed versus position of the helicopter.

Position of helicopter	No flotation installed	Flotation installed	Total
Remained upright	2	47	49
Inverted	63	197	260
Total	65	244	309
(χ^2 = 10.077, *df* = 1, *p* = .002)			

Table 4 pertains to the second hypothesis and shows the relationship between survivability (≤/>) 50 % and whether the helicopter had external flotation devices installed. A Chi-square analysis was conducted to examine the effect of external flotation devices on survivability (≤/> 50%). Table 4 clearly shows that the effect is not significant (p = .21).

Table 4. Survivability versus external flotation devices.

Survivability	No flotation installed	Flotation installed	Total
≤50%	35	77	112
>50%	74	221	295
Total	109	298	407
(χ^2 = 1.574, *df* = 1, *p* = .21)			

Relative Effects on Survival Rates. Figure 2 shows the relative effects of the variables and their influence on the overall survival rate. As can be seen, the installation of external floatation devices does not seem to significantly influence survival rates. What about the other variables? Is the immediate variable a sinking or inversion rate?

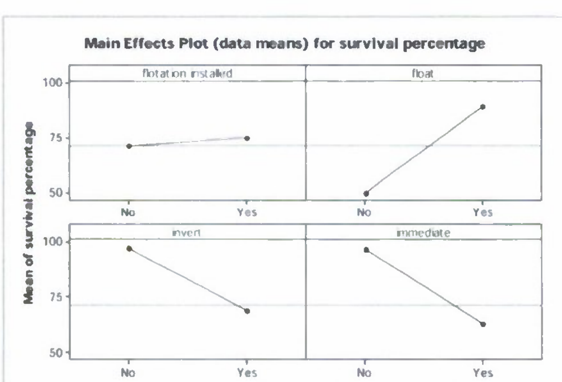

Figure 2. Survival rate versus flotation installed, float, invert and immediate variables.

LAST FIVE YEARS OF DITCHINGS (2000-2005)

The last five years (2000-2005) of ditching reports were examined through Chi-square analysis to explore the effect of the recommendations made by the CAA and FAA regarding the installation of external flotation devices. Within the last five years 117 ditchings have occurred. These cases included 486 passengers and crew. Of the 486 personnel, 314 (65%) were injured with 197 (40.5%) of those injuries being fatal.

The relationship between survivability (≤/> 50%) and position of the helicopter was found to be significant (p = .02). Further, the relationship between survivability and the immediacy of the helicopter inversion was found to be significant (p = .002). However, survivability and the installation of external flotation devices was not found to be significant (p = .708). As with the larger dataset, the most recent data only (2000-2005) found the installation of external flotation devices had no significant effect on survivability.

LIMITATIONS

One of the most important limitations to keep in mind relates to the amount of information contained in the preliminary accident investigation reports. Frequently, these reports do not include similar information or the equivalent amount of detail. These differences limited the number of cases and combinations of variables which the authors could analyse. In some of the reports the position of the helicopter as well as the presence of flotation devices was reported, yet in others only the position of the helicopter was reported. Moreover, the present study was unable to obtain the information required to identify the specific causes for each fatality due to limited human factor information contained in the preliminary reports. One further limitation of this study is related to the availability of reports. For example, limited access to military ditching reports reduced the number of cases that could be used for analysis.

DISCUSSION & CONCLUSIONS

The overall purpose of this study is to examine the relationship between external flotation devices and overall survivability (≤/> 50%). To interpret the findings, the first hypothesis suggests that survivability is linked to the position of the helicopter in relationship to the surface of the water. A significant relationship clearly exists between these factors. This finding is somewhat intuitive in that one can expect to have a more difficult time egressing from a helicopter that is sinking to the bottom of the lake or ocean, than evacuating an aircraft upright on the surface. If the helicopter remains upright at the surface, even an injured individual has the ability to continue breathing air; whereas a person below the surface will need to rely on breath holding capacity that may be impaired by the presence of cold water or the type of injury incurred during the ditching.

The second hypothesis is that external flotation devices contribute to overall survivability by keeping the helicopter at the surface. Interestingly, a significant relationship was not found to exist between flotation devices and survivability. This may be due to the fact that 16 ditching cases resulted in the aircraft inverting and remaining at the surface even though they did not have external flotation devices. A typical helicopter may have many of the void spaces within the passenger cabin filled with air. This trapped air may help to explain the cases in which aircraft did not sink despite the lack of external flotation devices.

Chen et al. (1993) suggest that inversion of the helicopter is closely related to overall survival rates. However, their study only examined survival rates in relation to immediate versus delayed inversion of the helicopter. The current study would support these findings, but also suggests that the relationship is influenced by the position of the helicopter during the occupants' egress or evacuation. Reader (1990) reports that keeping the aircraft at the surface of the water would aid in overall survival rates. Again, the current study would support these observations. Moreover, Reader suggests that the aircraft should have more flotation bags positioned around the midline of the helicopter to reduce the impact damage that may render the devices useless. In support of Reader's suggestion to reconsider how flotation devices are thought to impact survivability, this study did not find a significant effect of the currently designed external flotation devices and overall survivability. Even after examining the last five years of ditching reports, the authors did not find a significant relationship between flotation devices and overall survivability rates.

Perhaps looking beyond traditional forms of inflatable bags to investigating the possibilities of different types of flotation devices would be beneficial. For example, inherently buoyant flotation that could be installed in all of the void spaces within the helicopter may help alleviate some of the reliance on bags that could be damaged during an impact with the water. Future research and aerospace engineering studies should consider examining a hybrid flotation system that combines both inherent buoyancy and inflatable bags. However, it is doubtful that any of these combinations will completely remove the possibility of the helicopter inverting; therefore it is important to take steps to ensure that the helicopter is kept at the surface (inverted or upright) until all surviving occupants have had sufficient time to egress.

Although this study demonstrates that survivability and the position of the aircraft are significantly linked, it is not clear that the provision of external flotation devices alone will significantly affect survivability in helicopter ditchings. Many other factors may contribute to the overall survival rate of occupants. For example, human factors such as breath hold or temperature of the water will most likely play an important role in survivability. Further engineering is needed to ensure that flotation devices can be used effectively without compromising the overall performance of the helicopter, otherwise it is unlikely that overall survival rates will be greatly impacted.

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BIOGRAPHIES

Michael Taber is the Senior Instructor at Survival Systems Training Limited in Nova Scotia Canada. After gaining valuable helicopter experience in the Canadian Air Force, Michael joined the team of Offshore/Marine instructors at Survival Systems in 1997. As the Senior Instructor, Michael has trained military and civilian personnel from more than a dozen countries in Helicopter Underwater Escape Training, Casualty Extraction and basic water survival skills. Michael completed his Master of Science in Kinesiology at Dalhousie University and is currently pursuing his PhD while conducting further research concerning the survivability of personnel involved in helicopter ditching.

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Dry-Mixing of Sub-micron B and $BaCrO_4$ Particles for Use in A Time Delay Composition

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ABSTRACT

This paper is a study of a novel dry mixing technique called Magnetic Assisted Impaction Mixing (MAIM). This study will investigate the MAIM performance through mixing two powder components and determining the mechanism's mixing capability and how it impacts the mixed product's performance. The powder components used are Boron (B) and Barium Chromate ($BaCrO_4$), a time delay composition also known as T-10. This mixing method produced mixtures with a narrow particle size distribution range (0.1 – 6 μm). The corresponding Particle Size Distribution (PSD) results indicate that MAIM has a significant effect in breaking down the agglomerates of the components such that the final mixture size had a mean particle size of 1.5 μm. Imaging analysis of the MAIM mixture visibly showed that this method produced mixtures with a noticeable level of particle size uniformity, both on the micron and submicron level, as well as having improved distribution of boron throughout the mixture. The performance, burn rate, was tested and was well within the performance requirements. The results indicates that the MAIM quite easily achieves a uniform mixture with a good level of distribution between the two mixed constituents. A comparison between the MAIM product and another mixing product using the same mixing components, showed that the MAIM product clearly has a better particle size distribution and this is further noted in the increased distribution of B.

INTRODUCTION

Mixing particles is a significant process in many industrial operations. In every mixing classification, the mixing performance undoubtedly depends upon the level of homogeneity achieved in the mixing process and the type of materials to be mixed. Mixtures can be classified in one of two major groups: 1. Mixture containing free flowing particles; where free flowing mixture generally allows individual particulates to move independently; 2. Mixture with cohesive/Interactive constituents; where a cohesive mixture in general has inter particulate bonding mechanism, there by causing the particulates to move as a collection of particulates[1]. The T-10 mixture falls in the cohesive powder category, which creates the necessity for a mixing mechanism that also facilitates de-agglomeration of these cohesive particles.

Conventional industrial mixing equipment utilizes four major mixing devices; these are: tumbler, convective, hopper and fluidized mixers. Neither of these devices provides adequate de-agglomeration of particles with a mean particle size of several microns. Typically solvent based mixing yield better results. This is primarily because the fluid in which the particles are suspended, offering better dispersion between the particles to be mixed, and are mixed via the mixing mechanism relevant to the mixing device. However there are some inherent disadvantages of this process; most notable is that with the use of solvents drying the mixture becomes a necessary downstream process.

Another disadvantage for many mixtures using the wet mixing method, also the case with the existing wet mixing method being used for T-10, is that segregation will/occur(s); both when the slurry is stagnant and during the drying process. This segregation adversely affects the homogeneity of the mixture which can potentially adversely affect the mixture's level of mixedness as well its application performance.

In contrast, the dry mixing using MAIM eliminates the need for any type of wet mixing and utilizes a mixing mechanism that facilitates both mixing and the reduction of agglomerates. This MAIM offers greater functionality compared to conventional industrial mixers because of the reduced mixing time while producing the same quality and/or better mixing results while having an inherently effective de-agglomeration capability. Furthermore, MAIM eliminates many lengthy down stream processing associated with wet mixing methods, such as filtering and drying the filtrate etc, thus reducing to amount time needed to produce to a finial product.

EXPERIMENTAL

Figure 1 is a schematic of the MAIM apparatus. The system is comprised of a hollow circular electromagnetic powered by AC current coupled with a blower to prevent/cool the coils from over heating. The mixing vessel is placed inside the hollow section of the coils containing the mixture component and the mixing measured mass of magnetic particles are placed in the processing vessel all within the confines of a coil. The magnetic particles are made of barium ferrite and coated with polyurethane to prevent contamination of the coated particles. An external magnetic field is created using a series of electromagnets surrounding the processing vessel chamber and placed inside of a magnetic field. Once the magnetic field is present, the magnetic particles are agitated and move vigorously inside the vessel chamber, akin to a fluidized bed system where the powder is suspended. These agitated magnetic particles then impart energy to the T-10 particles by colliding and there by de-agglomeration coupled with mixing the two powders together.

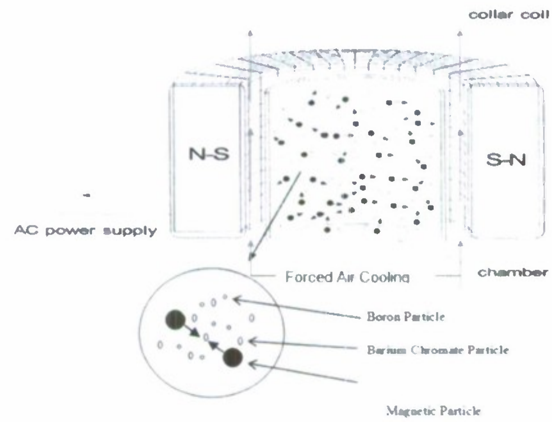

Figure 1 Schematic of Experimental Setup of Magnetic Assisted Impact Mixing Device

GENERAL DESCRIPTION

Characterization of the resulting B and $BaCrO_4$ mixture were conducted using Field Emission Scanning Electron Microscope (FE-SEM) equipped with an Electron Back Scatter (EBS) detector which provided higher Z contrast at extremely low accelerating voltage, resulting in better spatial resolution, a 200 kV Energy Filtering Transmission Electron Microscopy (EF-TEM) with Electron Energy Loss Spectroscopy (EELS), and other systems such as Particle Size Analyzer (LS-230).

For comparative analysis, the MAIM product was compare against NSWCIHD's[1] T-10 time delay mix and is illustrated in Figures 2-9. The MAIM consist of two sample sets; sample set A and sample set B, where A & B denoted magnet sizes of 430-850 μm and 750-1400 μm respectively. Each sample set relative to the mixing method consists of three samples with three different mixing times of 5, 10 and 20[2] minutes. The mixture composi-

[1] Naval Surface Warfare Center Indian Head Division
[2] Mixing in excess of 20 minutes does not yield any better or worse mixing results than that achieved in 20 minutes.

tion for all mixtures is as follows: 96% $BaCrO_4$ and 4% B by weight. Each MAIM batch used a 3:1 magnets to mixture mass ratio per sample size of 5 grams.

IV. RESULTS AND DISCUSSION

All FESEM images shown are at a magnifieation of 200X, as illustrated on the legend on all images.

Figures 2 & 3 (two different areas of MAIM sample), show that MAIM has a signifieant effeet in breaking down the agglomerates of the components sueh that the final mean mixture size by volume is redueed to approximately 1.5 microns, from 16 mierons for the B and 70+ mierons for the $BaCrO_4$. This shows that the MAIM method produees a mixture with a signifieant reduetion in agglomerate population and size. Based on the FESEM imaging and PSD analysis, it appears that this reduetion in agglomerate size faeilitates better mixing resulting in a mixture with visibly improved distribution of boron throughout the mixture, partieularly noting the Boron percentage of the mixture's eomposition.

Figures 4 through 5 are SEM images of T-10 mixtures from the Naval Surfaee Warfare Center in Indian Head (NSWCIHD). These mixtures are produeed in a slurry mix using a high shear mixer. Figures 4 & 5 eorrespond to two sample lots and served as a eomparative baseline for the MAIM produet. Figures 4a/b and 5a/b are the images for sample 1 (IHM04AT-10-001) and sample 2 (IHM-BD-4-83) respeetively (note images labeled a & b relate to different loeation areas of the respeetive sample). Sample 1 measured a mean partiele size distribution by volume of approximately 5.6 microns while sample 2 measured a mean size distribution of 2.9 microns (see figure 6). Furthermore, both NSWCIHD T-10 mixtures contain a fair amount of large boron agglomerates ranging from approximately 20-80 mierons.

A burn rate test of the MAIM T-10 mixture was eondueted at 200°F, 70°F and -65°F. The ealculated eoefficient of variation (CV) between the burn rates for a sample set, eaeh eonsisting of ten fired samples, had a CV less than 5%, the maximum allowed. Tables 1-6 eontain the burn rates and CV's for eaeh test at the three designated temperatures.

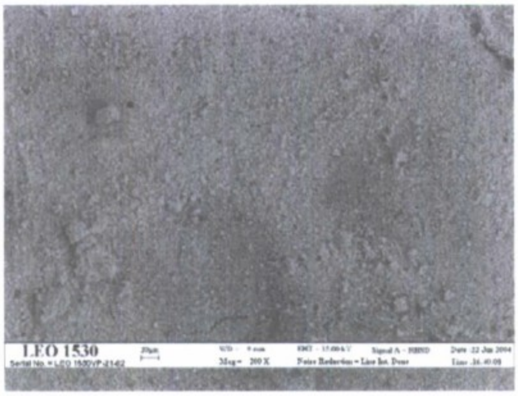

Figure 2 MAIM Mix 200X (20min; size A)

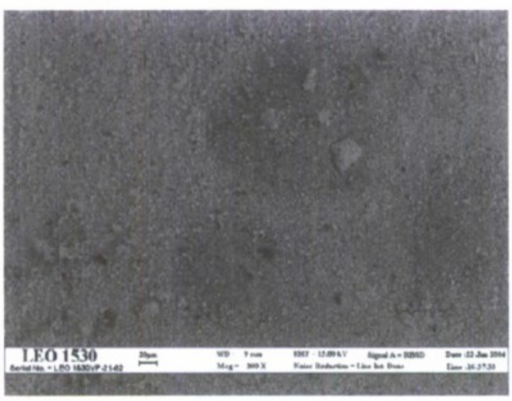

Figure 3 MAIM Mix 200X (20min; size A)

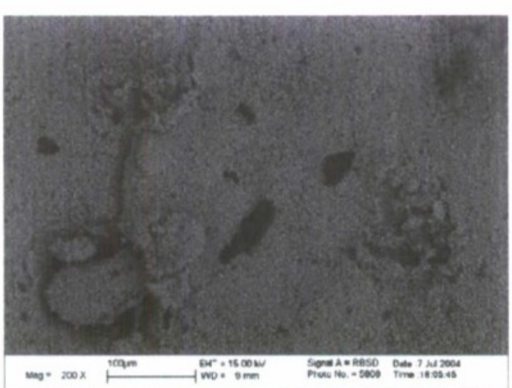

Figure 4a T-10 Mix 200X (sample 1)

Reference # (1HM04AT-10-001

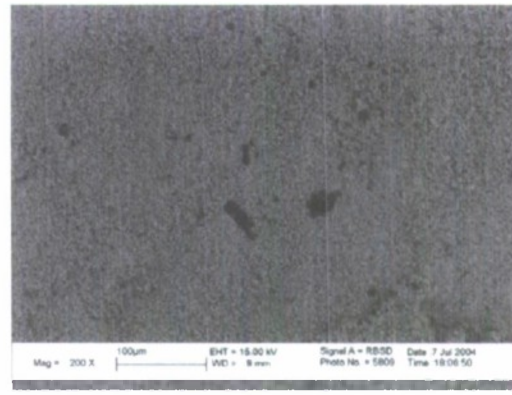

Figure 4b T-10 Mix 200X (another area of sample 1)

Reference # (1HM04AT-10-001)

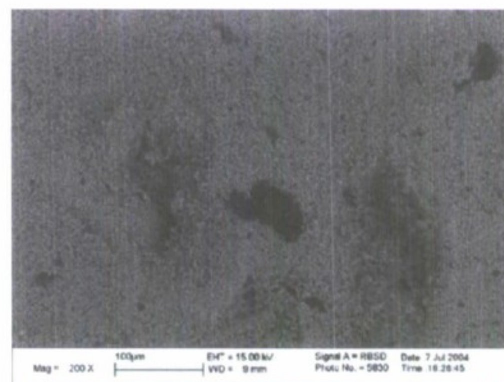

Figure 5a T-10 Mix 200X (sample 2)

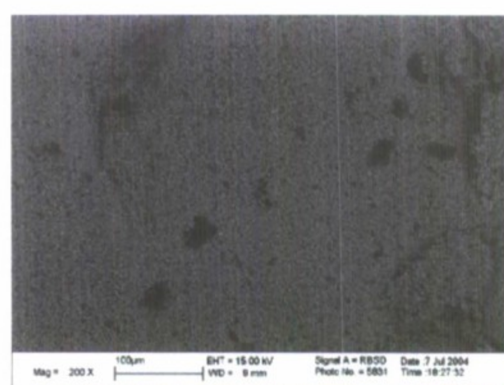

Figure 5b T-10 Mix 200X (another area of sample 2)

Reference # (1HM-BD-4-83)

MAIM 200^0 F	
#	IBR (s/in)
1	2.984
2	2.960
3	2.976
4	2.864
5	2.880
6	2.888
7	2.856
8	2.976
9	2.936
10	2.904

Table 1

MAIM 70^0 F	
#	IBR (s/in)
1	3.056
2	2.976
3	3.064
4	3.104
5	2.944
6	2.952
7	3.032
8	3.048
9	3.160
10	3.080

Table 2

MAIM -65^0 F	
#	IBR (s/in)
1	2.992
2	3.056
3	2.976
4	2.936
5	3.096
6	3.024
7	2.984
8	2.896
9	3.032
10	2.960

Table 3

200^o F Burn Rate Variations	
STDEV	0.050
Mean	2.922
CV	1.70%

Table 4

70^o F Burn Rate Variations	
STDEV	0.068
Mean	3.042
CV	2.25%

Table 5

-65^o F Burn Rates Variations	
STDEV	0.036
Mean	3.000
CV	1.96 %

Table 6

CONCLUSION

The MAIM mechanism has an effective de-agglomeration capability. Furthermore it suspends the particles during the mixing process thus better facilitating dispersion and mixing in this dry state. The MAIM level of de-agglomeration is significantly less than NSWCIHD samples, which are produced using the same component materials mixed in a high shear mixer, as illustrated in Figure 6. This intrinsic capability further enhances the mixing process as it helps to continually break up the formation of agglomerates, due to the cohesive nature of the dry submicron powders, and creates a conducive mixing environment for these solid state particles. Other benefits of using this process include: a significant reduction in total mixing time; a process which has no current negative impact on the environment; eliminates a lengthy drying process and produces a mixture with a uniform mean particle size of approximately 1.5 microns. Moreover, this process can potentially be scaled up with minimal building and environmental issues. Though it has not being discussed, safety of mixing energetic material and the sensitivity of the material regarding this mixing mechanism should be investigated further to identify necessary safety parameters specific to the materials. With that said, it should be noted that throughout this study, no incidences occurred while using the MAIM with neither the B and $BaCrO_4$ materials.

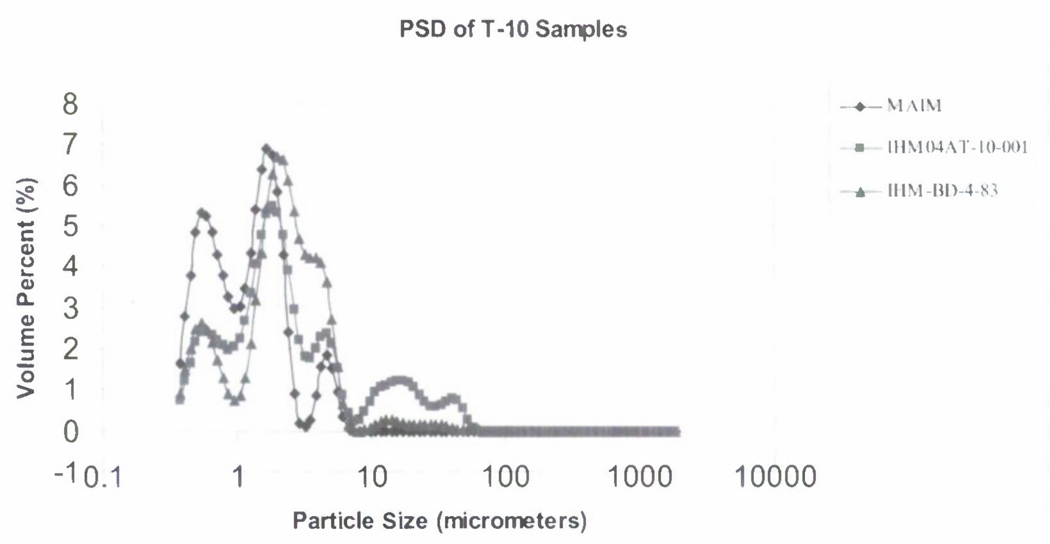

Figure 6 PSD of MAIM & NSWCIHD Samples

Due to the nature of the energetic materials being mixed in this process, safety is of paramount concern. As such this procedure should always be performed with extreme caution. All relevant and applicable safety guidelines relating to the material handling, material sensitivity, material processing (mixing, etc) and processing equipment (mixer, etc) should be strictly followed. Safe mixing in a dry state is achievable with the implementation of safe mixing and handling protocols. However, dry mixing of energetic materials is not a common practice in industry. As a result, many industries shy away from dry mixing of energetic materials, due to the inherent hazards and the risk associated with it, even though the results may indicate a better product as illustrated in this study. Still, it is my belief that this technology, despite the associated risk, should be explored in an effort to quantify the viability of this dry MAIM and establish real safety guidelines. Such research is necessary for continued evolution and understanding of mixing systems and how the mixing mechanisms impact them on the macro and micro level.

VI. ACKNOWLEDGEMENTS

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VII. REFERENCES

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(1990) pg 255-287.

Preparation, Characterization and Output Testing of Salts of 7-hydroxy-4,6-dinitrobenzofuroxan

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ABSTRACT

Pacific Scientific Energetic Materials Co. (PSEMC) in conjunction with chemists at NSWC-IH, has been involved (since 1999) with a program to develop new and existing energetic materials that could serve as drop in replacements for lead azide (LA) and lead styphnate (LS). Further these ingredients would incorporate no toxic or environmentally undesirable elements. These efforts have afforded a new primary explosive, 7-hydroxy-4,6-dinitrobenzofuroxan, as its potassium salt (KDNP, **1**, Figure 1). The material is conveniently prepared from 3-bromoanisole in 50-60% overall yield, via a 2-step procedure and can be synthesized on a relatively large scale. The product is isolated as a crystalline solid that can be easily recrystallized to generate a particle morphology suitable for use in detonators, etc.. The material exhibits good thermal stability with a DSC response in excess of 250 °C and compares well with lead styphnate in terms of friction and impact sensitivities. KDNP does not show a tendency to DDT and appears to be a promising lead styphnate alternative. Comparison of KDNP to normal lead styphnate (NLS) reveals that this new material can be easily initiated and more rapidly decomposes with higher output pressures.

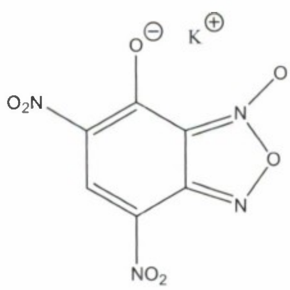
INTRODUCTION

Lead azide (LA) and lead styphnate (LS) are materials widely used in ordnance as priming mixtures for propellants, and as initiation and transfer charges in detonators for secondary explosives. The U.S. Army requires over 1000 lbs/year of lead azide alone for various uses (Mil. Spec. MIL-L-46225, 14758, 3055). Currently, there are no producers of lead azide in the United States; all production utilizes an existing stockpile of material which suffers from particle morphology issues related to aging. Lead styphnate is used in even greater quantities and is produced in the US for captive use only. It is used as an ignition element in hot-wire detonators and is a major ingredient in actuators and in both stab and percussion primers. As a consequence of these issues, there should be an excellent opportunity to introduce new materials into the production base for use in new and environmentally friendly detonators, etc.

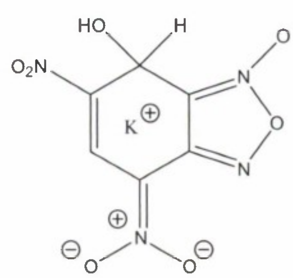
Both lead azide and lead styphnate release toxic heavy metal into the environment during use and disposal, and require toxic or carcinogenic materials in their manufacture. In 1993, a series of Executive Orders (EO 12856) were issued to reduce or eliminate procurement of hazardous substances and chemicals by federal facilities. These included directives to use acquisition programs aimed at encouraging new technologies and building markets for environmentally friendly products. The EPA is considering using Section 6 of the Toxic Substances Control Act (TSCA) to regulate sources of lead which they believe pose an "unreasonable risk" including ammunition. As a result, the Cartridge Actuated Device/Propellant Activated Device (CAD/PAD) Department at the Naval Surface Warfare Center-Indian Head (NSWC-IH) established a study to replace LA/LS with compounds/compositions that do not contain objectionable elements such as mercury, lead or barium. Pacific Scientific Energetic Materials Co. (PSEMC) in Chandler, AZ, in association with chemists at NSWC-IH, has been involved (since 1999) in a program to develop new and existing energetic materials which could serve as drop in replacements for lead azide (LA) and lead styphnate (LS), and would incorporate no toxic or environmentally undesirable elements. This program initially involved identification and critical review of, in conjunction with government and academic experts, existing materials which might be exploited for this purpose. The initial scope of this project involved 20 potential replacements, equally divided between LA and LS. From these materials, as well as new compounds developed during the course of the project, PSEMC has been successful in formulating a number of environmentally benign replacement candidates, some of which are currently undergoing further evaluation (Fronabarger et. al., 2006).

BACKGROUND

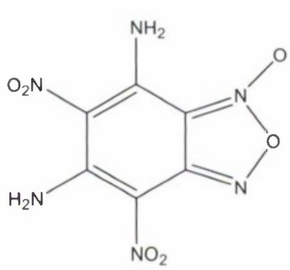
The potassium salt of 4,5-dinitro-7-hydroxy hydrobenzofuroxan (KDNBF, **2**, Figure 1) has been used as a primer explosive in igniters and detonators for many years (MIL-P-50486, 1971). This material exists as a Jackson-Meisenheimer adduct and is formed by the addition of hydroxide at C-7 of 4,6-dinitrobenzofuroxan.



4,6-Dinitro-7-hydroxybenzofuroxan, K salt, **1**



Potassium dinitrohydroxy hydrobenzofuroxan, KDNBF, **2**



CL-14, **3**

Figure 1. Structures of KDNP, KDNBF and CL-14.

This material is not a true phenoxide salt however and, despite the structural similarities between **2** and KDNP, the chemical differences are apparent when considering the contrast in DSC peak response temperatures of ~65 °C (KDNP, 284 °C, KDNBF, 217 °C). This is likely due to loss of aromaticity in KDNBF on hydroxide addition.

4,6-Dinitrobenzofuroxan was initially prepared in 1899 by Drost (Drost, 1899) and has undergone substantial chemical evaluation due to its extremely high electrophilicity. The 5,7-diamino-4,6-dinitro- analog is also well known (as CL-14, **3**, Chafin, 1988) and complexes of this material with various alkali metal salts have been prepared and evaluated as energetic materials (Sikder, 2004).

The preparation of KDNP is known (Norris, 1983) from commercially available 5-chlorobenzofuroxan. Nitration of this material gives 5-chloro-4,6-dinitrobenzofuroxan which is thermally unstable and spontaneously undergoes a Boulton-Katritzky type rearrangement (Katritzky, 1969) to give 7-chloro-4,6-dinitrobenzofuroxan. Reaction of this compound with potassium carbonate in water gives KDNP in reasonable yield; other carbonate bases may be substituted to generate the corresponding salts (e.g. sodium or cesium). The authors (Norris et. al.) indicated that additional studies on KDNP were needed but no subsequent publications have appeared in the literature.

KDNP directly isolated from this reaction series are brown needles (Ndls in Tables 1-3) which are unsuitable for handling and loading in standard initiators due to particle morphology. Additionally, KDNP from this sequence retains water (~6%, monohydrate) from the salt formation step and output is subsequently attenuated. These constraints imposed a need for a recrystallization step both to remove the water and to provide a more suitable particle morphology. The needles could be dissolved in 2-methoxyethanol and then recrystallized by slow addition of isopropanol to give an fine, amorphous material (Amrph in Tables 1-3) more suitable for initiator loading. DSC and TGA evaluation of this form of KDNP indicated that there was no water present and that the material was stable at elevated temperature for an extended period (120 °C, 5400 minutes).

An alternative synthetic procedure for preparation of KDNP is shown in Figure 2 and completely avoids use of water as a solvent. Starting with readily available and inexpensive 3-bromoanisole (**4**), exhaustive nitration

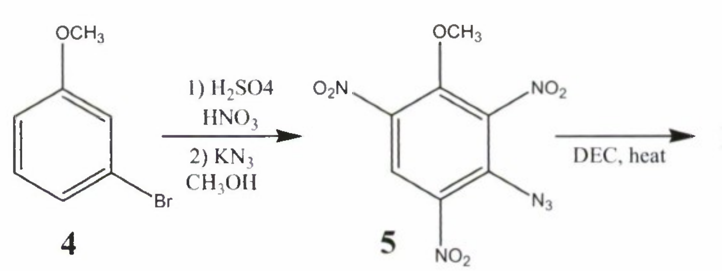


Figure 2. Preparation of KDNP (1)

using a mixed acid technique (Hein, 1968) furnishes the trinitroanisole. Reaction of this material with sodium or (preferably) potassium azide in methanol at reflux furnishes a solid intermediate (**5**) where an azido moiety has been substituted for bromine. Exchange of methanol with the higher boiling diethyl carbonate (DEC), followed by 2 hour reflux at 135°C, and then cooling and filtration gives KDNP (**1**) in somewhat better yield than the Norris procedure.

The latter procedure was initially used to prepare the sodium salt (from sodium azide) and the structure was confirmed by FTIR and ^{1}H and ^{13}C NMR techniques. TGA analysis of this salt confirmed that it was not isolated as the monohydrate, however it did adsorb water on standing Additional testing indicated that the sodium salt could add as much as 18% water on standing in humid conditions (92% RH, 25 °C, 5 hours) and output results with this material are again attenuated. The potassium salt did not demonstrate a tendency to adsorb water and was used in the remainder of the evaluations.

Again with the potassium salt, a recrystallization procedure was necessary to develop a suitable particle habit and a 2-methoxyethanol/ isopropanol technique was used to generate crystals (Cryst in Tables 1-3) in the 40-50 micron range. The ultimate size of the particles may be controlled by varying temperature and IPA addition rate during the recrystallization. TGA analysis of this salt confirmed that there was no water present (<1% wt. loss) and that the material was stable at elevated temperature for extended periods. The potassium salt gained <2% by weight when exposed to humid conditions (92% RH, 25 °C, 48 hours). The structure of the potassium salt was confirmed by X-ray (D. Parrish, NRL, private comm.).

RESULTS

KDNP prepared by the above methods were compared to each other and to lead styphnate (NLS, Lot GY90029) in a variety of evaluations. These evaluations were broken down into two areas including properties, to survey the chemical attributes and safety parameters (Tables 1 and 2) and performance, to determine the output characteristics (Table 3). KDNP and NLS samples were dried at 65 °C in a convection oven and stored in a desiccator until testing unless otherwise indicated.

Table 1 shows the density and thermal characteristics of the different particle morphologies of KDNP (**1**). The density was determined via helium pycnometry using a Micromeritics AccuPyc 1330 instrument fitted with a 1.25cc cell. Comparison of the KDNP sample densities to NLS indicates that they are all substantially lower as expected since these materials contain potassium rather than lead. The differences between density values for the various forms of KDNP are likely due to polymorphism which allows for variations in molecular conformation and crystal cell packing. High resolution infrared spectral analyses of these materials may provide some insight.

Table 1. Properties: Density and DSC Characteristics of Various KDNP Morphologies.

KDNP morphology	DSC (20°C/minute)		Bulk Density (g/cc)
	Onset	Peak	
Ndls	278°C	283°C	2.13
Amrph	266°C	275°C	1.97
Cryst	280°C	284°C	1.94
Styphnate	~280°C	305°C	3.20

The DSC spectra were run on a TA Instruments 2910 DSC apparatus and were run (as noted) at 20°C/minute. The DSC data indicate that KDNP is roughly equivalent to NLS in terms of onset and peak temperatures (and again substantially higher than that of KDNBF). The subtle changes in onset and peak temperatures observed for the KDNP samples are ascribed to the morphological changes which are known to influence these values as well as variations in minor amounts of impurities that may be present.

Table 2 shows safety characteristics for KDNP versus NLS. Friction data were determined in a Julius Peters small BAM tester and demonstrate that the KDNP is much less friction sensitive than milled NLS of a similar particle size. The KDNP needles are appreciably more friction sensitive than either the amorphous or crystalline material probably due to morphology and particle size issues and may be more suited to primer use. Variations in sensitivity due to polymorphism have been seen in a number of materials such as CL-20 or HMX. Impact data was determined using a ball drop method developed at

PSEMC. Since 2.5kg impact testers are not suited to primaries of this type, impact values were determined by dropping variable weight ball bearings (~8-30g) from varying heights onto a small amount of powder positioned on a steel block. The data were subjected to a Bruceton analysis. Impact results demonstrate that the crystalline KDNP is equivalent to milled NLS, while the needles and amorphous materials are less sensitive, again likely due to morphology and particle size differences.

Table 2. Safety: Friction and Impact Results of Various KDNP Morphologies.

KDNP morphology	Friction Levels (grams)		Impact (Joules)
	No-Fire	Fire	
Ndls	175	200	0.051±0.022
Amrph	1400	1500	0.051±0.010
Cryst	1300	1400	0.025±0.007
Styphnate	40	50	0.025±0.001

Performance tests (shown in Table 3) were run in a 10cc stainless steel bomb using a standard initiator having a 0.002 304SST (110 ohm/ft) one ohm bridgewire. Samples were loaded at 15 kpsi and units were fired into the bomb using a 10 ms 5 amp pulse. As seen in Table 1, the densities of the KDNP materials are substantially less than that of NLS so charge weights are lower. This produces impetus values for KDNP samples which are 90% higher than those for NLS on a weight basis (but only 16% greater on a volume basis). Importantly, the ignition times are comparable to NLS, while the rise times (from first indication of pressure to peak pressure) are faster in both non-amorphous KDNP materials. The cause for this disparity is currently unknown.

Table 3. Performance: Closed Bomb Pressure-Time Data.

KDNP morphology	Rise Time (ms)	Ignition Time (ms)	Peak Pressure (psi)	Impetus (Inch lb/g)
Ndls	0.190	ND	1513	6278
Amrph	0.400	0.760	1361	5572
Cryst	0.142	0.709	1602	6673
Styphnate	0.250	0.734	1361	3488

One attractive feature of KDNP may be the high post fire resistance (as is the case for other primary explosives such as KDNBF or barium styphnate). In some cases, high post fire resistance is desirable to avoid current drain on battery sources. Bridge wire ignition materials such as NLS and BLS (basic lead styphnate) and many pyrotechnics (e.g. ZPP [zirconium potassium perchlorate] and $B/CaCrO_4$) often display undesirable low post fire resistance.

As a result of the preliminary screening of KDNP above, Pacific Scientific has been awarded a NSWC-IH contract to undertake a performance evaluation of this material to replace NLS or BLS in a variety of hardware including CCU-63 impulse cartridges, TOW missile initiator units, MK102 stab primers and PVU 12/A percussion primers. In addition, PSEMC is conducting compound qualification tests as outlined in NAVSEAINST 8020.5C on KDNP. These tests are ongoing.

CONCLUSIONS

Considering the above data, the crystalline KDNP, conveniently prepared from 3-bromoanisole and recrystallized to the ideal morphology with low moisture content may be a suitable, non-toxic (and possibly drop-in) replacement for lead styphnate.

ACKNOWLEDGMENTS

The authors would like to acknowledge Drs. Alfred Stern, Peter Ostrowski, and Alex Schuman from NSWC-IH for technical support. The authors (JF, MW, WS) would also like to recognize financial support for this project provided by NSWC-IH (Contract N00174-06-C-0079).

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BIOGRAPHIES

John W. Fronabarger is a Senior Staff Scientist at Pacific Scientific Energetic Materials Co. in Chandler, AZ. He has 48 years of experience in energetic materials chemistry including design, synthesis and evaluation of novel aromatic and heterocyclic explosives. He has a BS in Chemistry and Mathematics from Southeast Missouri State University and did graduate work in organic chemistry at the University of Missouri, Columbia.

Michael D. Williams is a Senior Chemist at Pacific Scientific Energetic Materials Co. in Chandler, AZ. He has 20 years of experience in organic synthesis with 5 in the area of energetic materials. He has a BS in chemistry from St. Michael's College, Winooski, VT and a Ph.D. from Rensselaer Polytechnic Institute.

William B. Sanborn is a Staff Chemist at Pacific Scientific Energetic Materials Co. in Chandler, AZ. He has 14 years experience in the area of energetic materials chemistry. He has a BS in chemistry from North Carolina State University and a Ph.D. from Arizona State University.

Michael E. Sitzmann is a Research Chemist at Indian Head Division, Naval Surface Warfare Center (Indian Head, MD) and has 40 years experience in the synthesis and characterization of energetic materials. He has a BS from Benedictine College, Atchison, KS and a MS from the University of Colorado, Boulder, CO.

Magdy Bichay is a CAD R&D/PIP Branch Manager at Indian Head Division, Naval Surface Warfare Center (Indian Head, MD) and has been with NSWC-IH for 22 years. He has a degree in Chemical Engineering from CCNY and an MS degree in Engineering Management from George Washington University.

Trip Report: Department of Defense
Human Factors Engineering Technical Advisory Group
Highlights from Meeting #56, 6-9 November 2006

Stephen Merriman
The Boeing Company, Future Combat Systems
Richardson, Texas

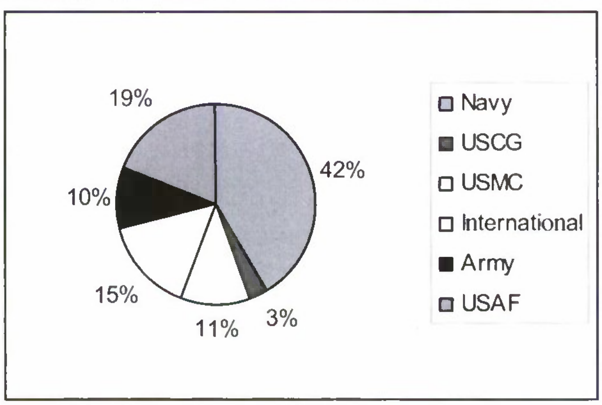
The 56th meeting of the DoD HFE TAG was held in Monterey, CA. The meeting was chaired by Mr. Adrian Salinas, 311th Human Systems Wing, Brooks AFB, Tx. The theme of the meeting was ***Realizing the Potential of Human Systems Integration***. Approximately 130 people attended the meeting, representing the US Army, US Navy, US Air Force, DARPA, NASA, FAA, DoD Laboratories, Canadian DRDC, several human factors-related technical societies and industry associations. Several additional personnel representing industry and academia attended as invited speakers.

Plenary Session Presentations

The DoD HFE TAG Chair for the 56th meeting, Adrian Salinas, welcomed attendees to the meeting and introduced the first plenary session presenter.

Navy Host Welcome and Command Overview

Mr. Jeff Kline (CAPT, USN (ret) provided an ***Overview of the Naval Postgraduate School (NPS).*** The NPS was founded in 1909 at the US Naval Academy in Annapolis, MD and moved to Monterey in 1951. A Human Systems Integration (HSI) Masters degree program was established at NPS in 2004. The current breakdown of students is:



NPS is currently an interagency/coalition research and education institution with three institutes: systems engineering, modeling and simulation, and communications and networks. There are 1776 residents with 937 students enrolled in degree and certificate programs. There are 15 short course programs. Current faculty numbers approximately 600, with 237 being in tenured positions. Approximately 44,000 students have graduated from NPS and there have been 50,000 non-degree participants.

NPS provides students with a unique learning and research environment. The NPS is resourced 44.1% from the Navy (mission funding for teaching) and 55.9% from research accounts. Research funding supports unmanned air, unmanned ground and undersea vehicles that are used for student research.

HSI in the Navy - Mr. John Owen, SEAPRINT Project Manager, NAVAIR 4.6, Orlando, FL. (john.owen@navy.mil) provided an overview of current ***HSI Projects Being Worked by the US Navy***. A SEAPRINT executive board is being established to provide intra-Navy cross-corporate overview.

Current HSI activities include:

- HSI integrated architecture (business processes, including all steps)
- SEAPRINT policy
- Level III data development
- IMPRINT-N phase II stressors
- IMPRINT-N Phase III whole person assessment
- Human capital demand signal planning system (automated business process)
- J-PRINT integration
- Support of DoD review of HSI
- HSI development strategy

The HSI development strategy addresses the seven tenets of SEAPRINT:

- Initiate HSI early,
- Identify issues and strategy, plan, conduct analysis
- Document/crosswalk HSI requirements
- Make HSI a factor in source selection
- Execute Integrated technical process
- Conduct proactive tradeoffs, integration and risk analysis
- Conduct HSI Milestone assessments

US Air Force HSI Challenges

Dr. Rick Drawbaugh (former USAF Colonel, Deputy for ESOH), principal advisor to the vice chief of staff for HSI, summarized the ***Current HSI challenges Facing the USAF***. The USAF HSI initiative includes all HSI domains: HFE, Manpower, Personnel, Training, Environment, Safety, Occupational Health, Personnel Survivability, and Habitability. The SECDEF (AT&L) has not published an HSI philosophy as of yet. The USAF policy directive on HSI is due out by the end of 2006. The USAF Instruction for HSI is progressing very slowly.

MANPRINT and Army Transformation: Watching Out for the Soldier in the Soldier System

Dr. John Warner, senior program analyst, Army MANPRINT Office (G-1) provided an overview of ***MANPRINT Mission, Objectives, Process, Assessments and Activities***. He went on to describe the MANPRINT Enterprise database initiative. This database will assist the G-1 office maintain oversight of the many Army development programs. He then summarized the challenges facing MANPRINT:

- MANPRINT in network-based systems of systems and operations
- Rapid response technology insertion/commercial COTS acquisition
- Umanned systems/robotics
- System of systems compexity
- New concepts

The Human-Systems Integration Standard (HSIS): A New NASA Human Factors Standard

Dr. Dane Russo, Johnson Space Center, Houston, Tx, (dane.m.russo@nasa.gov) discussed the new ***Human Factors Standard Development*** underway at NASA Houston. A new development process (as compared to NASA STD 3000) is being used. The standard will also differ considerably from NASA-STD-3000, which was:

- A mix of requirements and other information
- Extremely detailed
- Last updated in 1995
- Voluminous
- Aimed at micro-gravity
- Includes population extremes

The new standard will be global enough to apply to all human spaceflight programs, easily understood and used, flexible (durable) and less likely to be outdated by new technologies, and not contain specific design solutions. A design handbook will also be developed to guide application of the standard. Volume 1 of the new standard (Crew Medical Standard) has been reviewed and approved by the NASA Medical Policy Board. Volume 2 is in review and scheduled for submittal to HG by the end of 2006 and to the Medical Policy Board in January 2007. The design handbook development was begun in October 2006 and its planned release is in September 2007.

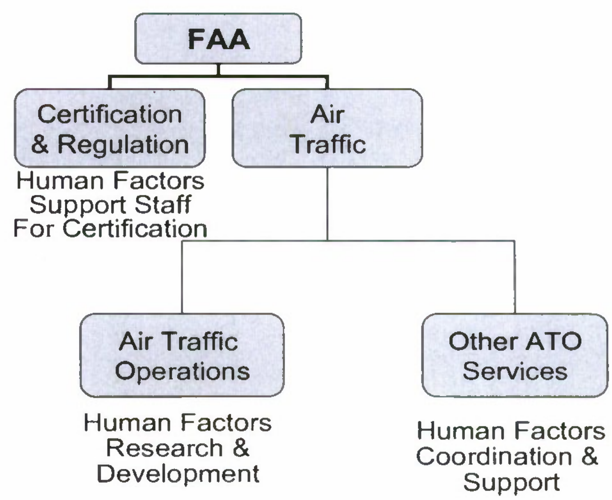
HSI in the FAA

Mr. Glen Hewitt, Federal Aviation Administration HQ, Washington, D.C. (glen.hewitt@faa.gov) provided an overview of HSI in the FAA, which oversees about 55,000 aircraft flights per day. A chronology of past events includes:

- 1988 US Office of Technical Assessment
- 1991 Human Factors RE&D office
- 1993 HF Policy & Guidelines
- 1995 Updated National Plan for Civil Aviation Human Factors
- 1996 STARS Lessons Learned
- 1997 FAA HF Acquisition Job Aid

FAA commonalities with the DoD include:

- Command and Control operations
- Major HSI focus on ATC in a well-defined acquisition management system
- Scope of HSI is broad
- HSI in National Airspace System Enterprise focused on technology and technology transition
- Difficulties in proving the case (business, safety) for HSI (worth).



FAA differences from DOD include:

- Manpower not a cornerstone
- Minimum safety compliance
- Difficult to find viable measures of performance
- HSI in acquisition is the "new kid on the block"
- IOT&E often isn't
- HSI is often a Government furnished item

Update on the HSI/MANPRINT Program Plan Data Item Description

Dr. Jennifer Narkevicius, Jeniussolutions (jnarkevicius@jeniussolutions.com) updated everyone on the DID. Following the June 06 HSI conference, Dick Armstrong updated the draft DID and provided it to the Navy for implementation. Publication is pending.

Poster Session (6:00 – 8:00 PM)

- The Effects of Accent and Medium on Comprehension - MAJ Okan OYMAK and CAPT Kamil AKEL (Turkish Army)
- Staying Alive: Effects of Cell-Phone Use on Pedestrian Situational Awareness - Maj Dave Sadlier, Norb Karczewski, Brent Laboo, and Chris Kirschman
- Delta3D: Open Source Game Engine for Training and Education - McDowell, Perry
- Augmented Visual Situation Awareness Using Tactile Situation Awareness Suit- LCDR James Brown
- The Effect Of Automation On Mission Planning In Armored Vehicles Of The Future - Tim McKnelly
- TBA- LCDR Leon Higgins and LT Demetrius Mack

Sub-Group Meetings Attended at the DOD HFE TAG

FORUM SECTION

Human Factors Standardization (HFS)

The chair/chair select for the Human Factors Standardization SubTAG is Mr. Dave Britton david.briton@wpafb.af.mil). Not attended.

Technical Society/Industry

The Technical Society/Industry (TS/I) Sub TAG met twice during the TAG meeting on Tuesday morning and afternoon. Dr. Jen Narkevicius (jnarkevicius@jeniussolutions.com) chaired the two meetings.

In the morning session,

- SAE G-13 Human Modeling Technology Committee develops standards to facilitate Human Factors assessment for equipment design. The 11th Digital Human Modeling conference will be held this year on the west coast.
- HFES Standards Activities: Mr. Cletis Booher (creidboo@hotmail.com) provided a brief status report.
- HSI DID Preparation: Dr. Narkevicius reported that the DID has been completed and has been submitted to the Navy for publication.
- ASTM: ASTM-STD-1166 is often called out in lieu of MIL-STD-1472. The HCI sections are reported to be superior to those of MIL-STD-1472.
- HFES Organization: There are four new main elements under the executive council – internal affairs, external affairs, annual meeting, and publications & outreach. A best practices working group has been established under the HFES institute; it is now developing a program, operating plan and budget. Mr. Al Poston (aposton@comcast.net) is a working group member under "Human Factors Standardization and Best Practices."

In the afternoon session, Drs. Nita Lewis Miller and Larry Shattuck (Naval Postgraduate School) provided information on the ***NPS Masters Degree Program in Human Systems Integration***. In February 2001, Walt Hollis (DoD executive) visited NPS; in June 2003, Dr. Robin Keesee included a Masters degree program in HSI on his "wish list; a curriculum was sculpted from existing courses and the first students were accepted in January 2004. The HSI program is a two year curriculum. There is a usability lab, with a/v recording, screen capture, keystroke capture, eye tracking, 2D motion capture system and a team performance lab (for command and control tasks). Dr. Miller is currently exploring methods of stimulating cooperative research with industry and the small business innovation research program (SBIR). She is also investigating internships and methods for industry to contribute financially to the program.

The second presentation was by Cadet Edgar and Cadet Tegman, who spoke on ***Evaluating Use of Graphic Representation in Social Network Analysis (SNA)***. Graphic representation in social network analysis has been used to investigate terrorist networks, gain a better understanding of our own networks, analyze communications within a unit, and increase efficiency in fielding gear based on Soldier preferences. Problems with using graphic representations include: graphic density and space limitations, information in the nodes versus on the edges, displaying connection weighting, and how best to show results. The cadets illustrated the technique and showed variations using weighted lines and different entity sizes.

Design Tools and Techniques

This sub-TAG is co chaired by Dr. Pamela Savage-Knepshield (Army Research Lab) and Mr. Joseph Barretta (Army Aberdeen Test Center). The first presenter was Dr. Glen Osga, Navy Space and Warfare Systems Center (glenn.osga@navy.mil) who spoke on ***Design Patterns***. Design patterns are used to help implement proven, standardized user interface designs and significantly reduce development time and cost. A YAHOO web site is now available. HCI patterns range from task generic (GUI components) to task specific (work/mission tasks). Patterns mus be useful (fit into design process, reduce cost, save time) and usable (understandable, retrievable, storable, flexible and compatible). A C4ISR pattern portal should be on line by January 2007; the URL will be distributed via the DoD HFE TAG.

The second presentation was provided by Barbara Burian, Ph.D., FRAeS, San Jose State University and NASA Ames (bburian@mail.arc.nasa.gov), on the ***Role of Emergency and Abnormal Checklists***. Dr. Burian provided an interesting presentation on checklists. Checklists guide (focus, guide, facilitate identification and trapping of errors, guide communications and coordination) crew responses to situations. Checklists must be consistent and complementary. It is extremely important to conduct scenario-based evaluation of checklists to catch errors such as sequence errors, layout problems, etc. Internal aspects of checklists include content, form, nomenclature, abbreviations and acronyms, layout, "look", organization, arrangement, access, purpose, logical coherence. An emergency procedures website has been established: http://human-factors.arc.nasa.gov/eas

The next presentation was by Dr. Pamela Savage-Knepshield (US Army Research Laboratory) on ***Methods for Collecting Warfighter Performance and Subjective Feedback: A Case Study from JTRS-HMS Program***. Dr. Knepshield described in detail the approach taken by human factors engineers to assess the usability of the Joint Tactical Radio System (JTRS).

The next presentation was by Mr. Jeffrey Thomas (US Army Research Laboratory (jthomas@arl.army.mil) who spoke on ***SALUTE-AP: Method for Evaluating Situational Awareness in a Field Experiment***. The object of this investigation was the evaluation of C4ISR operations on the move. Two 18-man platoons were equipped with, UGVs and small UAVs, C2 vehicles, unattended ground sensors, FCCB2 Battle Command Systems in vehicles and on Dismount soldiers' PC tablets. FBCB2 is used for imagery,, IM, Chat, Blue Force tracing, text messages. SA was rated from 1 (Low) to 3 H (High).

The next presentation was by Mr. Sheldon Hunt (Helmet Fire, Inc.) who spoke on ***Post-flight Data Collection System***. Four squadrons at North Island NAS and one at Oceana NAS were used. N45 (Force Safety) was the CNO sponsor for this work. After a flight, crews enter reports into a PC, the data are analyzed and reported every two weeks. Returning crews have only eight screens to go through, unless there is a desire to enter detailed information on a specific topic. Reporting is totally voluntary and anonymous. As data are collected, problems emerge and this information can be used in prioritizing resources for problem solution. Three stations were made available for each squadron and the stations operated continuously (24/7). Biographical data (crew skills, flight issues, squadron issues) are collected (27 skills and issues). Crews fill in information and can predict future occurrence probabilities. Analysis of data is done by humans. Statistical thresholds are used to flag issues. Persistent or recurring problem areas are flagged. Data is maintained on a six-week running average for each squadron. Overall, this reporting system has been very successful.

Modeling and Simulation

Lt. Jeff Grubb (NAVAIR, jeff.grubb@navy.mil) is the Modeling and Simulation SubTAG chair. Not attended.

Controls and Displays

The Controls and Displays SubTAG is chaired by Ms. Marianne Paulsen (Marianne.paulsen@navy.mil) and Mr. Justin Kingsford (justin.kingsford@navy.mil). The first presentation was by Mr. Sean Guarino (sguarino@cra.com) who spoke on ***Modular Adaptive Interface Suites (MAIS).***

The second presentation was by Mr. Christopher Voorheis (cvoorhei@arinc.com) who spoke on ***Unmanned Vehicle Mission Management Display.*** Experiments were conducted using SAGAT and TLX, reaction time and a system usability scale. The purpose of the experiments was to explore cost-benefit tradeoffs of unmanned systems and how to optimize human performance. Advantages of unmanned vehicles include:

- Removal of the human from risk in gaining advantage of an adversary
- Extend ability to collect information
- Extend surveillance area

Risk and opportunities associated with the use of unmanned systems include:

- Loss of Asset (ROI)
- Swarm effects – not well managed yet
- Loss of control / loss of communications
- Environment
- System failures
- Cognitive limitations
- Ethical risks
- Decision support tools for management
- Maintenance of global SA

Interoperability is critical. To assure interoperability, the following are important considerations:

- Coordinate distributed networks of autonomous, unmanned vehicles
- Develop a Common Operational Picture (COP)

- Distributed, networked capability will secure and sustain the decision advantage
- Surveillance, stealth and deception

Recommendations:

- Distributed networks of unmanned vehicles provide strategic advantage
- Develop decision support technology to address human performance challenges
- Implement a layered sensor approach to SA
- Evaluate technology in terms of interoperability advantages

User-Computer Interface

The Sub TAG meeting is co-chaired by Nausheen Momen, LT, MSC, USNR, Ph.D. (nmomen@namrl.navy.mil) and Stephen Merriman (stephen.c.merriman@boeing.com. There were 27 attendees at the User Computer Interaction SubTAG session, on Tuesday, 7 November 2006. No changes were proposed in SubTAG leadership at this meeting. Proposed revisions to the UCI SubTAG charter were proposed to reflect current TAG practices; the charter revision was approved by UCI members in attendance and later approved by the TAG Operating Board on 09 November. Four presentations were made at this session.

Presentation Title: **Achieving Human-System Integration in Systems Procurement: Obstacles and Methodological, Cultural, and Educational Solutions,** Kelly Neville, CHI Systems, Inc. (invited speaker)

Summary: Do current systems acquisition methods, processes, and practices support the achievement of human-system integration (HSI) in major systems acquisition? This question was investigated by conducting a review of systems engineering, software engineering, and cognitive engineering literature in parallel with an empirical analysis of systems development work. The work analysis involved assessing work descriptions elicited during retrospective interviews conducted with five expert systems and software engineers. The results of these research activities suggest that current methods and practices do not sufficiently address key challenges related to achieving HSI in system development. The identified challenges include: (1) assessing risk, system quality, and the development process in a balanced and more farsighted way; (2) addressing "penny foolish" practices that allow development challenges to be passed on to end-users who absorb the deferred costs in the form of make-work, work-arounds, and kluges; (3) supporting collaboration and negotiation so that numerous sub-teams and stakeholders can pursue their activities and goals in coordinated ways that are in keeping with program constraints and goals; (4) coping with changing constraints and creeping requirements; (5) identifying system requirements that meet stakeholder objectives and user support needs; (6) successfully integrating a new system with the target work environment; and (7) determining ways of calculating the risks and costs of not using cognitive analysis methods and results. Currently we are working on methodological, cultural, and education-based approaches to addressing these challenges. We propose to elaborate on identified challenges, describe potential solutions, and solicit the feedback of colleagues during Meeting 56 of the Department of Defense Human Factors Engineering Technical Advisory Group.

Presentation Title: **Human Factors Associated with Short-Wave Infrared and Image Intensifier Night Vision Devices,** Cadets Edward A. Anderson and Bryan Bhark (advisor LTC John Graham) United States Military Academy

Summary: There are issues with image intensifier (I^2) night vision devices that adversely affect its performance in combat environments. Many of these factors are environmental in nature; as a result, humans have very little control over these variables. During urban combat situations, soldiers using night vision devices may experience scene degradation due to a combination of lighting conditions and dust particles in the air (Richards & Dick, 2006). Haze also affects the visibility of soldiers who use I^2 devices. In addition, varying temperature differences, convection currents, and moonlight illumination levels significantly affect the variability in nighttime visibility when using Night Vision Goggles (NVG) (Sloan, 2006). The authors of this study will conduct a between-subjects experiment. One group of participants will use the Short Wave InfraRed (SWIR) sensor and the other group of participants will use the Image Intensifier sensor. The study will have approximately 24 participants (12 participants per group). The authors may utilize the contrast sensitivity chart and visual acuity chart that CDT Bhark created this summer in order to conduct a simple vision test with each sensor on each participant prior to conducting the actual experiment. We hypothesize that if the participant using SWIR night vision technology is able to correctly identify the specific recognizable features of the target through levels of processing and signal detection, then the participant will more accurately and more quickly determine the target's disposition and behavior compared to Image Intensifier. Based on the advantages of SWIR technology, we predict that it will have a shorter response time in regards to target identification compared to I^2. Additionally, SWIR's performance will be less degraded as compared to I^2.

Presentation Title: **Dynamically Reconfiguring Human-Computer Interfaces: Component Architectures for Role-based Systems,** Mike Hübler (Government Sponsor: Holly Boyett, Common Warfighter Machine Interface Office, US Army.

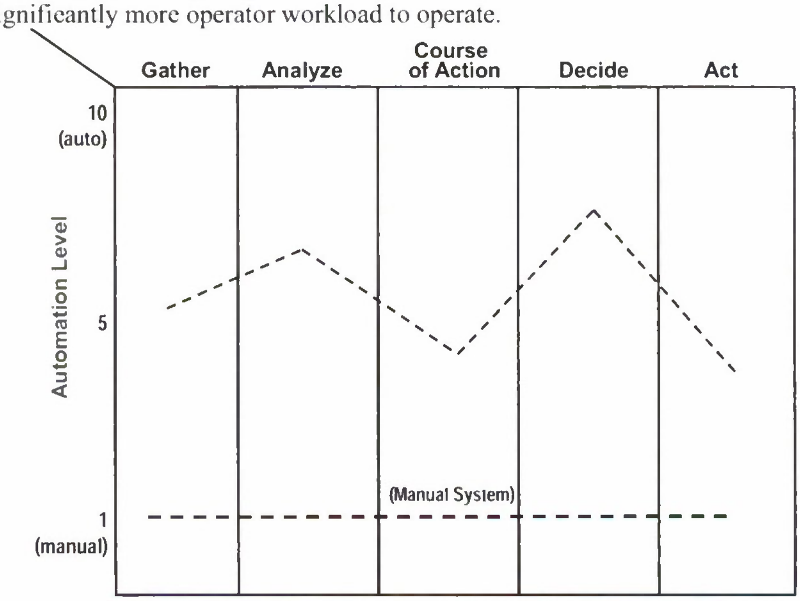
Summary: The Common War figher Machine Interface (CWMI) team is the government voice for all user interface issues in the Integrated Army Air and Missile Defense (IAMD) community. CWMI's expansive mission is challenged by a perennial human-machine interface problem, how to overcome information overload by presenting just the information a user needs when they need it. A component-focused, role-based architecture helps meet this challenge for complex user interfaces that span integrated C2 and weapons systems. The component is the primitive element of user interfaces for CWMI, each representing a common task among operators of IAMD systems. Component candidates are identified and associated with IAMD operator roles according to the findings of field observations, interviews, and military research. Role-based log-ins determine the component set and configuration that provides the information and functionality needs by the warfighter, and alternative component prototypes are tested at Fort Bliss.

Presentation Title: **Stereovision and its Applications (to tele-operated ground systems),** Dr. Barry Vaughn, US Army Research Lab, HRED, Aberdeen Proving Ground, MD

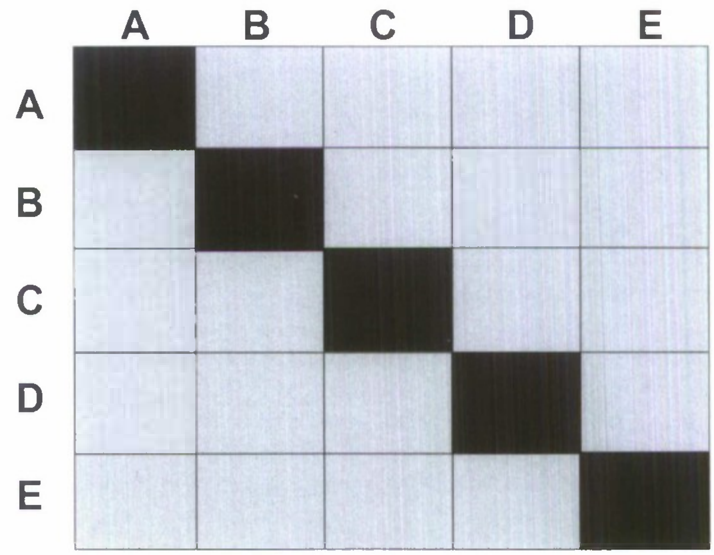
Summary: The Army Human Research and Engineering Directorate has been working in stereo vision for a long time, as have other organizations. Stereovision can improve safety and performance in a variety of tasks. Stereovision for unmanned system control is produced using two cameras mounted on a robot with the video signals transmitted as two separate signals, each presented to one eye of the operator. Lately, Army HRED has been exploring applications of stereovision to IED/EOD operations under a Robotic Collaboration Advanced technology Objective (ATO). The goals are to use stereovision to improve operator performance in tele-operation of ground vehicles as well as to provide data to support HRED modeling activities. Both laboratory and field trials are being conducted. Near-term goals are to demonstrate the benefits of retrofitting fielded hardware with COTS stereo systems with the aim. In the long term, the goal is to build up empirical evidence to influence decision makers into developing and fielding tele-operated platforms with integrated 3D.

Human Factors Engineering/Human Systems Integration: Management and Applications

The co-chairs for this SubTAG are Ms. Katrina Baker (katrina.baker@atc.army.mil) and Mr. Brad Collie bradley.collie@navy.mil. The first speaker was Mr. Josh. Kennedy, ARL, Redstone Arsenal, (josh-kennedy@us.army.mil) who spoke on ***Human-Automation Interface Model to Guide Automation Design of System Function***. This work is being done as part of a thesis in conjunction with Mr. Jeff Powers at BAE systems. In the FCS program, there is no consistent plan in place for an overall human-automation interface scheme. The manned ground vehicles (MGV) fleet lacks an overarching top-down approach to automation. There is a need to develop a functional architecture and a qualitative model (IMPRINT) IMPRINT models were built to represent a completely manual system and one in which there was significant automation (see figure immediately below) In comparing operator workload between the IMPRINT models, the manual system was determined to require significantly more operator workload to operate.



The next presenter was John Burns, Ph.D. from NAVAIR Orlando (john.j.burns@navy.mil) who spoke on ***The Design Structure Matrix: Application to HSI for Unmanned Air System Airspace Integration.*** The issue is – how to operate UAS in the National air space, integrated with manned systems. In 2004, the USAF Scientific Advisory board determined that there were $700Million and 35 fatalities annually due to UAS mishaps. In 2005, a review determined there were 56 UAS accidents and $ 13M cost. The challenge was to work with the FAA and military services to develop validated standards to integrate UAS more effectively into the National Air Space. The design structure matrix is a simple, concise visual system representation tool that facilitates design process modeling. The goal of this effort was to use the DSM to bring HSI into the acquisition process for the unmanned air system.



Design Structure Matrix

The next presenter was Major Carolyn Shaw, Defence Research and Development Canada –DRDC (Carolyn.Shaw@drdc-rddc.gc.ca) who spoke on ***Adding a Human View to the DoD Architectural Framework***. This work on Human Views is to identify those architectural products (views) that facilitate linkage and transfer of pertinent information between a capability engineering team of systems engineers and architects that are developing investment options at the capability level, and the strategic analysts resident within the Human Resource (HR) domain who are responsible for assessing and predicting implications of the same to future HR requirements and capacities. This work has good prospects for increasing the level of attention paid to HSI during system development.

The next speaker was Mr. James Buxton (US Army Aberdeen Test Center, james.buxton@atc.army.mil) who made a brief presentation entitled ***Measuring Human Cognitive Performance***, using electro-encephalographic processing techniques.

The last presenter was Dr. Lesia Crumpton-Young (University of Central Florida, lcrumpto@mail.ucf.edu) who spoke on ***Modeling Stress Under Dynamic Conditions***. There is both positive and negative stress. A stressor is that which creates stress. There are Processive stressors ("fight or flight" that release stress hormones) and Systemic stressors (that disturb body homeostasis and produced autonomic physiological responses – e.g., acid stomach). The focus of research at UCF is on acute stress, and the physiological and cognitive reactions to stress, such as:

Physiological Reactions	**Cognitive Reactions**
Heart rate increase	Change in response time
Blood pressure increase	Changes in working memory
Increases in sweat rate	Changes in spatial manipulation difficulty
Adrenaline & Cortisol levels	Changes in Situational Awareness (SA)
Mobilization of energy resources	Difficulty in concentration
Depletion of stress hormones	
Unbalanced homeostasis	
Decreased ability to respond to stress over time	

Reduced blood flow to extremities

Modeling of stress at UCF is proceeding using intelligent systems technology, mathematical modeling, predictive modeling and fuzzy set theory. Future research will investigate the feasibility of designing a "stress meter." At this time, the Total Body Fatigue Estimation Model is complete; this model includes heart rate, response time (auditory and visual choice RT) tiredness response and Yashitaki symptoms.

Personnel Selection and Classification

Not attended.

Sustained/Continuous Operations (SUSOPS/CONOPS)

Not attended.

Workload and Stress

The chair of the Workload and Stress SubTAGis Ms. Debra Patton (Army Research Laboratory, **dpatton@arl.army.mil**). The first presenter was Dr. Lesia Crumpton-Young who presented the **Total Body Fatigue Estimator: A State-of-the-Art Software Tool**. The goal is to understand when fatigue affects performance. The model is based on different types of tasks. There are different modules for sedentary tasks and more physically –active tasks. Data can be input directly into the models or read in from data files. Outputs are numerical, graphic and linguistic.

The second presenter was Marilyn Dudley- Rowley, Ph.D. (OPS Alaska) who spoke on ***MIR Workload and Stress-Lessons Learned***. The third presenter was Ms. Jessica Mock, NASA Orbital Project Office, who spoke on ***Stress, Fatigue and Workload – Determining Combined Effects on Human Performance***. The focus is on evaluating human performance with flight controls. Subjective tools include NASA TLX and Yoshitake Fatigue. Physiological measures include heart rate and blood pressure. Task measures include completion time, # of problems worked, repeated performance, communications and identification of errors.

The next presenter was Mr. Carlos Cardillo, who spoke on ***Quantitative EEG (QEEG) Changes Under Continual Wakefulness and with Fatigue Countermeasures***. Sleep deprivation results in alpha wave attenuation and increases in delta and theta waves, as initial signs of sleepiness. Results of different medical interventions were studied: caffeine (200 mg), Dextroamphetamine (5 mg), Modafonil (100 mg) and placebo. Modafonil was found to work (result in maintenance of normal performance) for up to 40 hours of sleep deprivation. Correct doses must be used, correcting for individual differences. Two channels of EEG data were obtained (frontal and occipital lobes); these were determined to be sufficient to track changes. EEG could provide real-time data for commanders to monitor the alertness of aviators (or other operators).

The fifth presenter was Mr. Wade Allen (Systems Technology, Inc.) who spoke on ***Psychomotor Testing of Sleep Deprivation Effects***. The goal was to determine a simple, efficient measure of fitness for duty of sleep-deprived personnel. The following measures were investigated:

- Critical Tracking Task (CTT)
- Psychomotor Vigilance Task (PVT)
- Driving Simulator (DS)
- Epworth Sleepiness Scale
- Stanford Sleepiness Scale
- Visual Analogue Scale (VAS)

It was found that the CTT was the most efficient test in that it takes only one minute to administer. The Driving Simulator was the most sensitive test, but it takes one hour. It was determined that CTT is a good fitness for duty test. The next step is to apply CTT to hospital workers.

The last presentation was by Mr. Al Sciarreta (CNS Technology), who spoke on ***HFE Considerations for Stabilization and Reconstruction Operators***. The military doesn't discriminate well between Stabilization (maintaining order) and Reconstruction (Rebuilding infrastructure such as roads). The difference between combat operations and stabilization/reconstruction are:

- Restricted Maneuvering

- More a "dismounted policeman" than a mounted war fighter
- Inability to understand the environment
- More background clutter (EM emissions, cell phones, etc.)
- Reconnaissance spans larger areas
- Long haul logistics is the norm.

In the Abrams tank, the crew must pop out of the hatch to use the machine gun. In stabilization/reconstruction environments, enemies dropped hand grenades into the tanks, so the crews had to button up, producing a very difficult situation. A Situational Awareness camera was added to the tank plus the capability to shoot the gun from inside the tank. Also, a tank infantry phone was added to the back of the tank. Radios are desperately needed for dismounted troops. And, batteries must be standardized across devices.

Human Factors in Training

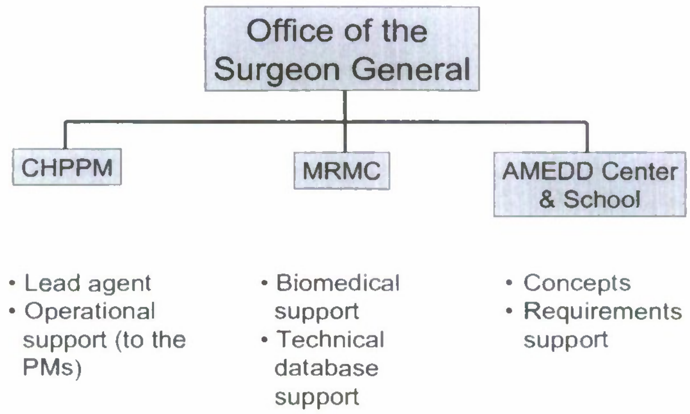
Not attended.

System Safety/Health Hazards/Survivability

The co-chairs for this SubTAG are Mr. George Murnyak (George.murnyak@amedd.army.mil) and Ms. Barbara Palmer (Palmer_barbara@bah.com). The first presentation was by Mr. Joseph Pellettieve, USAF Research Laboratory/HEPA, who spoke on the ***Collaborative Biomechanics Safety Database.*** This web-based database can interface to JACK models. There are currently over 750 registered users; registration and use are free. The point of contact is Colonel John Crowley, USAARL, Ft. Rucker. The database structure is easily adaptable for other content areas.

The next presentation was by Ms. Marilyn Dudley-Rowley, Ops Alaska, who spoke on ***"MIR Crew Safety Record."*** In 1985, Rockwell identified safety risks applicable to space operations: fire, explosion, collision, decompression, contamination, radiation, and other. In 1986 MIR was designed for a 10 year life span. MIR stays are not exactly like Shuttle flights in that regular rest, work breaks and psychological breaks are needed. The closed atmosphere, with temperature and humidity control issues (ethylene glycol, CO_2, etc.) create a lot of anxiety.

The last presenter was George Murnyak (USACHPPM, **george.murnyak@amedd.army.mil**) who spoke on ***Army Health Hazards Assessment Program.*** The Army medical program provides support to MANPRINT. The proponent is the Army Surgeon General. Governing regulations are: DoD 5000 series, AR 70-1, AR 40-10 and others. Key Health hazard documents are: the acquisition strategy, PESHE, test reports, safety/HHA report, operations manuals and Operational Mission mode/Summary. The organization is as shown below.



Some of the areas covered by the Health Hazards program are: acoustics, biological substances, chemicals radiation, shock and trauma, hot and cold extremes. CHPPM has 42 technical programs, including environmental factors, HHA, Hearing conservation, Entomological Sciences, Industrial Hygiene, Ergonomics, Medicine, Health and Safety.

Following the presentations, Barbara Palmer and Bob Lindberg (311 HSW) described an initiative of theirs to identify primary points of contact in the Army, Navy, Air Force, FAA and NASA for the System Safety, Health Hazards, and Survivability Domains of HSI/MANPRINT, as well as the POC for HSI/MANPRINT. So far, only Army POCs have been identified.

DOD HFE TAG Operating Board Meeting:

1. **SubTAG Reports:** SubTAG chairs reported numbers of presentations, charter changes and other items of interest.
2. **Caucus Reports:** Army, Navy, Air Force, FAA and NASA reported results of caucus meetings
3. **Human Robotics Intervention Interest Group:** The interest group met as a closed government meeting at TAG-56. Open sessions should be scheduled in the future.
4. **Call for Papers:** If SubTAG chairs want anything specific placed into the call for papers, they need to get the information to the TAG coordinator two months ahead of the TAG meeting.
5. **Dr. Foster Initiative:** Dr. Foster (TAG Proponent) may hold small meetings of SES/Executives in conjunction with future TAG meetings.
6. **TAG Endorsement of Papers:** A request was received from one of the services for the TAG to endorse a specific paper. The TAG will not endorse papers.
7. **On-site Registration**: The possibility of having on-site registration was discussed, and an charging additional fee (~$25) for the privilege.
8. **Publication of Papers on TAG Website**: Prior to posting papers on the TAG web-site, permission must first be obtained from the authors.

DOD HFE TAG Background

The DoD HFE TAG was begun via memorandum of agreement signed by the Service Secretaries in November 1976. Goals of the TAG were established as follows:

- Provide a mechanism for exchange of technical information in the development and application of human factors engineering.
- Enhance working level coordination among Government agencies involved in HFE technology research, development and application.
- Identify human factors engineering technical issues and technology gaps.
- Encourage and sponsor in-depth technical interaction, including subgroups as required in selected topical areas.
- Assist as required in the preparation and coordination of Tri-Service documents such as Technology Coordinating Papers and Topical Reviews.

The TAG addresses research and technologies designed to impact man-machine system development and operation throughout the complete system life cycle. Topics include:

- Procedures for use by HFE specialists, system analysts and design engineers in providing HFE support during system development and modification
- Methodologies to identify and solve operator/maintainer problems related to equipment design, operation and cost/effectiveness
- Mechanisms for applying HFE technologies, including formal and informal approaches to validation and implementation, and the determination of time windows for application.

The TAG comprises technical representatives from Government agencies with research and development responsibilities in the topical areas mentioned above. Additional representatives from activities with allied interests affiliate with the TAG as appropriate. Technical experts in special topic areas may augment attendance at specific meetings. Also participating in the TAG are official representatives of technical societies (e.g., Human Factors and Ergonomics Society, SAFE Association) and industrial associations (e.g., Electronics Industry Alliance) with a stated interest in HFE. These representatives may attend subgroup and general plenary sessions and they must be credentialed by the TAG prior to attending any meetings.

Inside the Beltway: Spring 2007

Steve Madey
Washington Liaison, Capital Resources, LLC

With the State of the Union address completed in January and the budget request submitted in February and the supplemetal for '07 vetoed in May, action in the 110th Congress has begun. It's been a long time since the first Congress in 1788, but we are working under the same constitution (albeit a-mended) as then, and will see divided government at work. Remember: separate institutions - shared power. The administration cannot pass a law, the Congress cannot govern, and though it sometimes seems the judiciary wants to do both, the judiciary is in between the Congress and the administration. Given all that and the political division of the Congress and the administration, we should have an interesting session ahead.

For more defined interests, in January the Congressional budget analysts forecast a $172 billion deficit for the fiscal year that ends Sept. 30—a marked improvement from the previous fiscal year and an even bigger drop from predictions the Congressional Budget Office (CBO) made in August. The FY06 deficit was $248 billion, and CBO previously forecast a $286 billion deficit for FY07. If the new figures hold, it would be the lowest deficit figure in dollar terms in five years, and a $114 billion change from CBO's projection just five months ago. In a report accompanying the new forecast, CBO said the shift was due mostly to lower than anticipated spending, including on Medicare, and to a lesser extent higher than expected revenues. "We are now on a solid path toward the president's new goal to achieve a balanced budget by 2012, while making the tax cuts permanent and better constraining spending," OMB Director Portman said in statement. According to CBO, if current policies were to continue—meaning tax cuts expire on schedule at the end of 2010—the budget would swing back into surplus in FY12 to the tune of $170 billion.

This all has implications of course. With an improving deficit scenario and a new majority it's difficult to see the way ahead. Will the new majority mark up the request with members' priorities, or essentially accept the administrations allocation of resources? The first telling event was the new majority's handling of the supplemental spending request early in the session. It will be around $100 *billion* aimed mostly at DOD for current operations.

Congress not only did not give the administration unrestrained freedom to prosecute the war but also filled the bill with its own priorities – that is, earmarks to the tune of $20 billion in *additions*.

On the other side of the Potomac, the Pentagon is in a budget war of its own that will play out in the E-ring offices of senior defense and military officials as well as in the halls of Congress, with each service battling over money to invest in new weaponry as well as to cover rising Army and Marine Corps personnel costs. Until now, the Pentagon has largely divvied up the services' shares of the defense budget the same way every year: the Army receives 24 percent, the Air Force 29 percent, and the Navy and Marines a combined 31 percent. It is a delicate balance that has kept the services from moving aggressively to raid each other's accounts to pay for their additional needs.

The Army Chief of Staff launched a risky bid last fall to get the Army more money to pay for modernization and transformation efforts and cover the costs of base closures and relocating troops from Europe to the United States. But he made it clear he was not interested in taking money from the Air Force or Navy. But recently announced plans to grow the ground forces by 92,000 troops over the next five years -- an expansion intended to ease the stress of constant deployments to Iraq and Afghanistan -- could upset the interservice peace over budget shares. Those extra troops will cost roughly $90 billion through 2013, and another $15 billion to $20 billion annually after that, estimated Steve Kosiak, a budget analyst at the Center for Strategic and Budgetary Assessments.

Army officials plan to pay for the beginning of that increase in the wartime supplemental spending bill that accompanied the FY08 budget, but say they will have to wrap those costs into the base budget request in FY09 and beyond. That money has to come from somewhere -- and the Air Force and Navy are "very, very nervous" that the Pentagon will plunder their accounts, said Robert Work, another CSBA analyst.

So, from inside the Beltway things are mostly focused on the process and competition that will somehow combine to yield policy.

'Til next time.

Information for Journal Authors

Initial Manuscript Submission: Original manuscripts must be submitted double spaced to the SAFE Office at the following e-mail address: safe@peak.org, and include all figures and pictures. SAFE retains the sole decision right to publish submitted information or request edits. Articles that have appeared in the SAFE Symposium Proceedings are acceptable for submission to the Journal, in the proceedings format. The choice of reviewers remains the sole responsibility of the editor if the author requests peer review.

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Illustrations, tables, and photographs: Illustrations and photographs are considered figures and shall be so labeled, numbered in sequence as they appear in the text using Arabic numerals. Illustrations will be original or clear copies. Photographs will be glossy photographic or computer-generated prints. Tables will be so labeled, numbered in sequence using Arabic numerals. Legends will be of sufficient explanatory detail as to provide sufficient information without reference to the text.

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Biographical Sketch: Biographical sketches of each author and co-author for a maximum of the first three authors is allowed, but not required. These should be brief and without photographs. Pertinent information about the author that allows the reader to evaluate their level of expertise and their contact information is acceptable.

Final Manuscript Submission: Upon acceptance of the manuscript for publication in the SAFE Journal, a final manuscript using Microsoft Word must be submitted to the above e-mail address in final form, as it will appear in the Journal. Times New Roman 10 (PC) or Times 10 (MAC) font is preferred using two columns per page. Do not number the pages. Figures and Tables should be inserted in the text where appropriate. At the base of the first column on the first page must be a statement of the date that the manuscript was received by the editor and the date that it was accepted for publication. This information is obtained from the editor upon acceptance of the manuscript for publication. Detailed information on developing a final manuscript for publication, including a format template, is available on the SAFE website, www.safeassociation.org under Publications.

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